A Simplified CFD method for the Design of Heat Exchangers

Brian Spalding
Concentration Heat and Momentum Limited

Keynote Lecture at the ASME 2005 Summer Heat Transfer Conference on
Advanced Computational Methods and Applications for Heat Exchanger Design

Abstract

Traditional heat-exchanger design methods do not predict steady-state uniform-property performance well; and they are totally unable to predict the influences of time-dependence and varying properties or the consequent stresses in the shell and tubes.

On the other hand, conventional CFD (computational fluid dynamics) techniques, with their emphasis on body-fitting grids and sophisticated turbulence models, can contribute only to small-scale phenomena such as the velocity and temperature distributions within the space occupied by a few-tube sub-section of a tube bank.

Nevertheless, the practical importance of heat exchangers, including those which involve chemical reaction and phase change, is so great that engineers must find design tools which are both economically-affordable and more realistic in prediction than either of the just-mentioned extremes.

Such tools discretize space and time with the fineness allowed by modern computers; but they still inevitably employ space intervals which are large compared with tube diameters. They have been used for research purposes for many years; however, the difficulty of supplying them with all the relevant empirical input data has deterred designers from using them.

The lecture will describe a means of greatly reducing the difficulty; it accepts the formulae (for heat-transfer coefficients, viscosity-temperature relations, etc) in the form with which designers are familiar; and it also produces more information, for example about local heat fluxes, hot-spots and stress concentrations, which otherwise escapes attention.

Examples will be presented and explained.